OVERVIEW OF ATRAZINE RISK ASSESSMENT

May 2, 2002

Introduction

This document summarizes EPA's human health, environmental fate and transport, and ecological risk findings for the herbicide atrazine, as presented fully in the documents, "Atrazine: HED's Revised Human Health Risk Assessment for the Reregistration Eligibility Decision (RED)," dated April 16, 2002 and "Reregistration Eligibility Science Chapter for Atrazine: Environmental Fate and Effects Chapter," dated April 16, 2002. The purpose of this overview is to assist the reader in understanding the conclusions reached in the assessments by identifying the key features and findings of each. References to relevant sections in the complete documents are provided to allow the reader to find the place in these assessments where a more detailed explanation exists. The overview was developed in response to comments and requests from the public that indicated that the risk assessments were difficult to understand, too lengthy, and that it was not easy to compare the assessments for different chemicals due to the use of different formats.

These atrazine risk assessments and additional supporting documents will be posted on EPA's website (http://www.epa.gov/oppsrrd1/reregistration/atrazine/index.htm) shortly and will be available in the Pesticide Docket for public viewing. Meetings with stakeholders (i.e., registrants, growers and grower groups, extension officials, environmental organizations, water associations, and other interested parties) are planned to discuss the risk assessments, the identified risks, and to solicit input on risk management strategies. This feedback will be used to complete the interim Reregistration Eligibility Decision (IRED) document that presents the Agency's reregistration and risk management decisions. The Agency plans to conduct close-out conference calls with interested stakeholders and regulatory partners to describe the regulatory decisions to be presented in the IRED.

Risks summarized in this document are those that result only from the use of atrazine. The Food Quality Protection Act (FQPA) requires that the Agency consider "available information" concerning the cumulative effects of a particular pesticide's residues and "other substances that have a common mechanism of toxicity." The reason for consideration of other substances is due to the possibility that low-level exposures to multiple chemical substances that cause a common toxic effect by a common mechanism could lead to the same adverse health effect as would a higher level of exposure to any of the other substances individually. The Agency has not yet performed a cumulative risk assessment as part of this reregistration review of atrazine; however, the Agency recently determined that atrazine, simazine, propazine, and their common chlorinated degradates share a common mechanism of toxicity. Cyanazine was not considered in the decision because it is no longer a registered pesticide. Thus, the Agency will be conducting a cumulative risk assessment for these triazines in the future. Further, the

Agency is in the process of developing criteria for characterizing and testing endocrine disrupting chemicals and plans to implement an Endocrine Disruptor Screening Program. Atrazine will be reevaluated at that time and additional testing may be required.

This overview summarizes the results of the Agency's revised risk assessments for atrazine. Following a 60-day public comment period, the Agency will make its reregistration decision and release the IRED for public comment.

Use Profile

- **Herbicide:** Atrazine is used on corn (field and sweet), sorghum, sugarcane, wheat (application to wheat stubble on fallow land following harvest), guava, macadamia nuts, hay, pasture, summer fallow, forestry or woodlands, conifers, woody ornamentals, Christmas trees, sod, and residential and recreational turf (parks, golf courses). Given the specific nature of the turf uses, much of atrazine's use on lawns is confined to Florida and the Southeast.

- **Formulations:** Formulated as an emulsifiable concentrate, flowable concentrate, water dispersable granular (dry flowable), soluble concentrate, wettable powder, granular, and as a ready-to-use formulation.

- **Methods of Application:** Atrazine may be applied by groundboom sprayer, aircraft, tractor-drawn spreader, rights-of-way sprayer, hand-held sprayers, backpack sprayer, lawn handgun, push-type spreader, and bellygrinder.

- **Use Rates:** Maximum application rates range up to 4.0 lb ai/A or lb ai/gal (conifer forests, sugarcane, Christmas tree farms, sod farms (FL), Bermuda grass highway rights-of-way). The number of maximum allowable applications ranges between 1 and 2 per season or year when specified.

- **Annual Poundage:** Total annual domestic use averages approximately 76 million pounds of active ingredient. Crops with the highest percent crop treated are field corn (75%), sugarcane (76%), sorghum (59%), sweet corn (processed) (58%) and sweet corn (fresh) (50%). In terms of pounds applied, corn (86%), sorghum (10%), and sugarcane (3%) account for the greatest use. Less than 1% of atrazine applied is for forestry, turf, and other uses.

- **Registrants:** Agan Chemical Manufacturing, LTD., Drexel Chemical Company, Oxon Italia S.P.A., Platte Chemical Company Inc., Sanachem LTD., and Syngenta Crop Protection Inc.

Human Health Risk Assessment

Cancer Classification

- In the late 1980s, EPA classified the carcinogenic potential of atrazine as "possible," or category "C" under the cancer assessment guidelines issued in 1986. In 1994, the Agency initiated a Special Review of atrazine's potential to cause human cancer through dietary or occupation exposure to the pesticide.

- During the 1990s, the Agency reviewed the available data and found that there is a plausible mechanism of action for the carcinogenic effects of atrazine and tentatively concluded that the classification of atrazine's carcinogenic potential of atrazine should be changed from "category C" to "likely human carcinogen" in accordance with newer terminology from the proposed cancer guidelines.

- The FIFRA Scientific Advisory Panel (SAP) reviewed the Agency's draft hazard characterization document in June 2000 and agreed that a mode of action had been established for the tumorigenic effect of atrazine in the species and strain(s) in which such effects occur. However, the SAP determined that the mechanism that produced tumors in the rat was not relevant to humans and that the evidence did not support classifying atrazine as a "likely human carcinogen." The SAP recommended that the Agency classify atrazine as "not a likely human carcinogen."

- The Agency has reviewed and accepted the SAP's conclusion on the cancer classification The current risk assessment uses a non-cancer endpoint as the basis for regulating atrazine exposures.

FQPA Considerations

(For a complete discussion, see section 3.2 of the Human Health Risk Assessment)

- The atrazine risk assessment considers risks related to exposure to atrazine as well as its chlorinated metabolites and hydroxy-metabolites. For the purposes of this assessment, the toxicity of atrazine's chlorinated metabolites is equivalent to the toxicity of atrazine parent compound. The toxic effects attributed to the hydroxy-metabolites are not equivalent to atrazine; therefore, risks associated with exposure to these metabolites have been assessed separately.

- The default FQPA Safety Factor of 10x is required for atrazine and its chlorinated metabolites (represented as DACT) for all population subgroups for dietary exposure scenarios because of the absence of reliable evidence showing that an additional safety factor different than the 10x default would be protective of infants and children. This determination was based on the following rationale:

    - There are residual concerns for the effect of the neuroendocrine mode of action described for atrazine on the development of young. These concerns could not be accounted for in the determination of toxicity endpoints and traditional

uncertainty factors to be used in the risk assessment.

- There are residual concerns with the drinking water exposure assessment. Water monitoring data that exist for atrazine and its chlorinated metabolites indicate that exposure via drinking water sources is high in some of the systems that have been monitored and widespread low levels are commonly detected. Although it is known that there is significant, widespread exposure to atrazine and its metabolites in drinking water, limitations in the extent, frequency, and compounds tested for in the monitoring data raise significant uncertainties regarding the level of exposure to atrazine and its metabolites.

- An FQPA Safety Factor of 3x was applied to atrazine for all population subgroups for residential exposure scenarios. The special FQPA safety factor of 3x is adequate for assessing residential exposures to atrazine because the concerns for drinking water would have little or no impact on the residential exposure scenarios. This determination was based on the following rationale:

  - There are residual concerns for the effect of the neuroendocrine mode of action described for atrazine on the development of young. These concerns could not be accounted for in the determination of toxicity endpoints and traditional uncertainty factors to be used in the risk assessment.

  - The concerns for drinking water would have little or not impact on the residential exposure scenarios.

- The 10x FQPA safety factor was applied across all aggregate risk assessments based on estimated dietary exposures for all populations considered in these risk assessments. The 3x FQPA safety factor was applied across all aggregate risk assessments based on estimated residential exposures for all populations considered in these risk assessments.

- The FQPA Safety Factor was removed for hydroxyatrazine for all population subgroups based on the following rationale:

  - The is no evidence of increased susceptibility in the prenatal developmental toxicity study in rats;

  - There is no evidence of neurotoxicity from submitted toxicity studies;

  - The neuroendocrine effects described for atrazine are postulated to be part of a cancer mode of action for atrazine. Since hydroxyatrazine is non-carcinogenic, the current belief is that the neuroendocrine effects described for atrazine are not occurring following hydroxyatrazine exposure;

  - The dietary and non-dietary exposure assessments do not underestimate the potential exposures for infants and children; and

- The drinking water exposure concerns expressed for atrazine and the chlorinated metabolites do no apply to hydroxyatrazine, given its dissimilar toxicological profile and environmental fate properties that indicate that hydroxyatrazine is less mobile in soil/water systems.

Acute Dietary (Food) Risk

(For a complete discussion, see section 4.2.2 of the Human Health Risk Assessment)

Acute dietary risk is calculated considering foods eaten in one day (consumption) and atrazine residue values in or on the food eaten by the general population and each subpopulation of interest. The consumption distribution was either multiplied by a residue point estimate for a deterministic-type (i.e., Tier I/II) exposure assessment, or used with a residue distribution in a Tier III probabilistic-type (Monte Carlo) exposure assessment. A risk estimate that is less than 100% of the acute Population Adjusted Dose (aPAD; the dose at which an individual could be exposed on any given day that would not be expected to result in adverse health effects) does not exceed the Agency's risk concern.

The Agency performed a revised probabilistic Tier 3 (Monte-Carlo) acute dietary exposure assessment to estimate the dietary risks associated with the registration of atrazine. This assessment uses statistical methodology for applying existing information to acute dietary risk assessments. Acute risk estimates from exposures to food, associated with the use of atrazine do not exceed the Agency's level of concern. The estimated acute dietary (food only) risk is less than 1% of the aPAD at the 99.9^{th} percentile of exposure for the relevant population subgroup, females 13-50 years old.

- The Dietary Exposure Evaluation Model (DEEM™) was used to estimate acute dietary exposures from consumption of foods that contain atrazine residues.

- Atrazine residues may be either concentrated or reduced by the activities of drying (prunes etc.), processing (juice, catsup, etc.), washing, peeling, and cooking. Dietary Exposure Evaluation Model (DEEM™) default factors were used in this assessment for all commodities except sugarcane since processing data were limited. Commodity-specific data were used for sugarcane.

- The toxicological endpoint selected for atrazine and its chlorinated metabolites for the acute dietary assessment is delayed ossification of certain cranial bones in fetuses and decreased body weight gain in adults in rats (NOAEL= 10 mg/kg/day) where effects were observed at 70 mg/kg/day (LOAEL) from the weight of the evidence evaluation of four developmental toxicity study in rats and rabbits.

- This endpoint is appropriate for the females 13 to 50 years old population subgroup only. An appropriate endpoint for the general population including infants and children could not be derived from the available oral toxicity studies.

- No toxicological endpoint was selected for the hydroxy metabolites of atrazine for the acute dietary assessment because the Agency has concluded that no toxicologically significant endpoint to represent a single exposure can be found in the toxicology database for hydroxyatrazine. Therefore, no acute dietary assessment was conducted for these metabolites.

- The Uncertainty Factor is 100x; 10x to account for interspecies extrapolation and 10x to account for intraspecies variability. The 10x FQPA Safety Factor was retained as described earlier for atrazine and its chlorinated metabolites.

- The acute dietary RfD is 0.1 mg/kg/day and the aPAD is 0.01 mg/kg/day for females 13-50.

Chronic Dietary (Food) Risk

(For a complete discussion, see section 4.2.3 of the Human Health Risk Assessment)

Chronic dietary risk is calculated by using the average consumption value for food and average residue values on those foods over a 70-year lifetime. A risk estimate that is less than 100% of the chronic RfD (the dose at which an individual could be exposed over the course of a lifetime and no adverse health effects would be expected) does not exceed the Agency's risk concern. The cPAD is the chronic reference dose (cRfD) adjusted for the FQPA Safety Factor.

Chronic risk estimates from exposures in food to 1) atrazine and its chlorinated metabolites, and 2) the hydroxy-metabolites, do not exceed the Agency's level of concern. The chronic dietary (food only) risk estimate is less than 1% of the cPAD for all population subgroups in both cases.

- The toxicity endpoint for the chronic dietary assessment for atrazine and its chloro-metabolites is attenuation of pre-ovulatory lutenizing hormone (LH) surge as a biomarker indicative of hypothalamic function disruption based on the results of a 6-month LH surge study in rats (NOAEL = 1.8 mg/kg/day), in which effects were seen after 4 to 5 months of dosing. This attenuation is believed to result in the inhibition of ovulation and potential delay in puberty for both males and females. These effects were observed at 3.65 mg/kg/day (LOAEL).

- The toxicity endpoint for the chronic dietary assessment for atrazine's hydroxy-metabolites is histopathological lesions of the kidneys based on the results of a combined chronic toxicity/carcinogenicity study in rats (NOAEL = 1.0 mg/kg/day). These effects were observed at 7.75 mg/kg/day (LOAEL).

- The uncertainty factor is 100x; 10x for intraspecies variation and 10x for interspecies extrapolation. The 10x FQPA Safety Factor was retained as described earlier for atrazine and its chlorinated metabolites. The 10x FQPA Safety Factor was removed for the hydroxy-metabolites of atrazine, as described earlier.

- For atrazine and its chlorinated metabolites, the chronic RfD is calculated to be 0.018 mg/kg/day. The cPAD is 0.0018 mg/kg/day for all populations.

- For atrazine's hydroxy-metabolites, the chronic RfD is calculated to be 0.01 mg/kg/day. The cPAD is 0.01 mg/kg/day for all populations.

Drinking Water Dietary Risk

(For a complete discussion, see section 4.3 of the Human Health Risk Assessment)

Drinking water exposure to pesticides can occur through groundwater and surface water contamination. EPA typically considers both acute (one day) and chronic (lifetime) drinking water exposures and uses either modeling or actual monitoring data, if available, to estimate those exposures. In the case of atrazine, based on its use pattern, the Agency also considered seasonal or intermediate-term exposures to atrazine residues in drinking water, since the "spring flush" is typically when the highest exposures to atrazine residues are expected to occur in drinking water. Atrazine is the most commonly detected pesticide in ground and surface water.

To determine the maximum allowable contribution of residues in drinking water, EPA first looks at how much of the overall allowable exposure is contributed by food, calculates the remaining "allowable" exposure through drinking water, and then based on this value determines a "drinking water level of comparison" (DWLOC). The DWLOCs represent the maximum contribution to the human diet (in ppb or µg/L) that may be attributed to residues of a pesticide in drinking water after dietary exposure is subtracted from the aPAD or cPAD. This DWLOC value is compared to estimated environmental concentrations (EECs) in surface water and groundwater from models or directly to monitoring data. Since the DWLOC represents a theoretical limit on the concentration of a pesticide allowed in drinking water, if the EECs from models or measured residues from monitoring data exceed DWLOC values, the Agency reports a drinking water risk estimate of concern.

As described above, the Agency uses DWLOC values as a surrogate to estimate potential risks associated with exposure from pesticides in drinking water. DWLOC values will vary for different population subgroups based on differences in the default assumptions regarding body weight and drinking water consumption for those population subgroups. The Agency assumes a body weight to a daily drinking water consumption rate of 70 kg/2L for adult males, 60 kg/2L for adult females, and 10 kg/1 L for infants and children.

In the case of atrazine, there is a great deal of monitoring data available for ambient water quality, residues in drinking water sources, and residues in finished drinking water. The quality of the monitoring database used in the risk assessment is considered to be high. Typically, in the absence of appropriate monitoring data, the Agency relies on models to estimate environmental concentrations of residues in water. Drinking water modeling is considered to be an unrefined assessment and provides high-end estimates. In this case, given the available monitoring data, these data were used in the risk assessment rather than modeled

results.

Atrazine Exposure Assessment

Atrazine is currently regulated under the Safe Drinking Water Act (SDWA). A Maximum Contaminant Level (MCL) of 3 ppb was established in 1991 by the Agency's Office of Water (OW). The OW has also established a One-Day Health Advisory Level (HAL) of 100 ppb for one-day exposures to atrazine in drinking water. Under the SDWA, Community Water Systems (CWSs) are required to monitor for atrazine. The monitoring data collected under SDWA were used extensively in this risk assessment where appropriate. Additional monitoring data were supplied by the registrant for CWSs with high-end exposures to atrazine residues.

Monitoring data were available to estimate exposures to atrazine and its chlorinated metabolites for two distinct subpopulations: populations served by Community Water Systems (CWS) using surface water in the 21 states with major atrazine use (~75,000,000 people) and populations using private wells located in atrazine use areas for their drinking water (10% of the population). Monitoring data were also available for populations served by CWSs relying on groundwater or blended sources in the 21 states with major atrazine use (~74,000,000 people) for atrazine only. A refined, probabilistic analysis was conducted by the Agency using the additional monitoring data available for those populations served by a CWS using surface water targeted as having "high-end" exposures. Regression analyses were conducted to estimate concentrations of the chlorinated metabolites for the one-day, seasonal or intermediate-term, and long-term exposure durations.

Because of the limited monitoring data available on hydroxyatrazine, and the Agency's determination that hydroxyatrazine is unlikely to contaminate surface water to the same degree as atrazine and its chlorinated metabolites, quantitative exposure assessments were not conducted for the hydroxy-metabolites. Qualitative estimates of exposure have been developed and are presented below.

Screening-level risk estimates have been developed for a number of drinking water source categories. Estimates are provided for acute, intermediate and chronic exposure. Acute exposures are based on maximum one-day concentrations. Intermediate-term exposures are based on 3-month (90-day) average concentrations. Chronic exposures are based on annual average concentrations. Monitored concentrations are compared to the appropriate DWLOC values to determine whether there is the potential for a risk of concern. The intermediate-term exposures are compared to the chronic DWLOC since the chronic effect (LH surge attenuation) occurs between 30 days to 5 months of daily exposure, depending on the dose level in animal studies.

The Agency has refined, where appropriate, its drinking water risk estimates using probabilistic techniques that consider all available distributional data on drinking water residues, body weights, and drinking water consumption. The probabilistic approach has reduced the uncertainty associated with the current screening-level deterministic drinking water risk

assessment.

CWSs using Surface Water

Monitoring Data Used

This assessment used compliance monitoring data collected under the SDWA on finished drinking water from 1993 to 1998 for 3670 CWS. These CWS used surface water and were located in 21 states with major atrazine use. Under the SDWA, finished drinking water samples are collected a maximum of 4 times per year (or quarterly). This database covers approximately 75 million people receiving their drinking waster from CWS using surface water.

Additional monitoring data from a subset of targeted CWS with high-end exposures to atrazine residues were also used to refine exposure estimates for one-day, intermediate-term, and chronic exposures for those populations believed to be the most highly exposed. The additional monitoring program included weekly sampling from May through July and biweekly sampling for the remainder of the year. This additional monitoring allowed for the estimation of the chlorinated metabolites in CWS using surface water.

Acute

The Agency's screening level risk assessment concluded that no population group receiving their drinking water from CWSs using surface water is exposed to combined atrazine and its chlorinated metabolites in drinking water at a level that poses an acute risk of concern. That is, combined measured concentrations of atrazine plus estimates of the chlorinated metabolites in finished drinking water for all populations do not exceed acute DWLOC levels. The highest one-day concentration from all available data was 89 ppb. The acute DWLOC for females 13-50 years old, the population subgroup of concern for acute exposure scenarios, is 298 ppb.

Intermediate-Term and Chronic

The Agency's screening level risk assessment for intermediate-term and chronic effects identified 29 CWS out of the original 3670 for a probabilistic assessment based on a comparison of average seasonal concentrations of atrazine and the chlorinated metabolites to a DWLOC of 12.5. These CWS were identified for probabilistic assessment based on quarterly average concentrations approaching, equal to, or greater than 12.5 ppb for infants in one, two, or three years between 1993 and 2001.

Probabilistic assessments were conducted for 28 CWS, most of which were identified as of concern under a screening level assessment. In total, 29 CWS (assessed either deterministically or probabilistically) had 90-day average exposure to atrazine and the chlorinated metabolites that exceed levels of concern for at least one year between 1993 and 2001. Risk estimates for these CWS ranged from 100% to 670% of the chronic PAD at the

99.9th percentile exposure. Several also exceeded for children 1 to 6 years old and adults, as well. The 29 CWS are located in:

- Illinois (Gillespie, Hettick, Salem, Palmyra-Modesto, Hillsboro, Farina, Kinmundy, ADGPTV, Carlinville, West Salem, Flora, Sorento, White Hall, Louisville, and Centralia);
- Iowa (Chariton);
- Louisiana (Iberville);
- Indiana (Batesville, Holland, North Vernon, Scottsburg);
- Kentucky (Lewisburg, Marion);
- Missouri (Bucklin, Dearborn, Drexel, Vandalia); and
- Ohio (Newark, Sardinia).

Rural Wells

Monitoring Data Used

The registrant also provided a database containing residue data on atrazine, its chlorinated metabolites, and its four hydroxy-metabolites called the Rural Well Survey. This survey contained data for 1505 private, rural drinking water wells in 19 states with major atrazine use sampled from September 1992 to March 1995. These wells were rural wells targeted for their location in atrazine use areas and selected in conjunction with the Department of Agriculture for each state included in the survey based on their proximity to farms growing corn, general location in atrazine use areas, and depth to water. Each well was sampled one time only, and analyzed for atrazine, desethyl atrazine (DEA), desisopropyl atrazine (DIA), diaminochloro triazine (DACT), hydroxyatrazine, desethylhydroxyatrazine, desisopropylhydroxyatrazine, and diaminohydroxyatrazine. Because only one sample per well has been taken and analyzed, exposure to atrazine residues in these private rural wells for acute and chronic effects has necessarily been based on a single concentration value. This database is most useful for estimating exposures to that portion of the population that get their drinking water from domestic rural wells located in close proximity to areas of atrazine use.

Acute

The monitoring data available for rural wells is limited to a single sample (measurement) (atrazine and chloro-metabolite) for each well monitored. Therefore, this concentration was used to estimate both the maximum and average concentrations for the purposes of the risk assessment. The highest measured concentration in the database is 18 ppb.

The Agency's screening level risk assessment concluded that no population group who receive their drinking water from private rural wells is exposed to combined atrazine chlorinated metabolite residues in drinking water at a level that poses an acute risk of concern.

Chronic

The Agency's chronic risk assessment concludes that there are some chronic risk estimates that exceed the Agency's level of concern from exposure to residues of atrazine and its chlorinated metabolites to infants and children who receive their drinking water from private rural wells in proximity to atrazine use areas. 8 out of 1505 sampled wells had concentrations greater than the chronic DWLOC of 12.5 ppb.

CWSs Using Groundwater or Blended Water

Monitoring data on atrazine were available under the SDWA for ~16,000 CWS using groundwater or a blend of groundwater and surface water. Available monitoring data under SDWA for CWSs which use either groundwater or blended water (water from a combination of surface water and ground water sources) are limited to atrazine and do not include measurements of the chlorinated metabolites.

The registrant has generated data to estimate concentrations of the chlorinated metabolites of atrazine in CWS using groundwater. A total of 439 groundwater CWS (235 with no prior atrazine detections; 204 with prior detections of atrazine) were sampled once or twice and analyzed for total chlorotriazines.

Acute, Intermediate-Term, and Chronic

The highest concentration of atrazine and the chlorinated metabolites measured in any groundwater CWS well in the survey was ~11 ppb, less than the acute DWLOC of 289 ppb. The 50th percentile concentration value was 0.180 ppb for wells with prior detections, less than the intermediate-term and chronic DWLOC of 12.5 ppb. The Agency has high confidence that exposures to atrazine and the chlorinated metabolites is low in CWS using groundwater and is not of concern.

Hydroxy-Metabolites in Drinking Water

As mentioned earlier, exposure assessments were not conducted for the hydroxy-metabolites. The Agency does not expect that levels of these metabolites will exceed levels of atrazine and the chlorinated metabolites in drinking water. The chronic DWLOC for hydroxyatrazine exposure to infants (the most highly exposed population subgroup) is 69 ppb. This is well above the maximum measured time-weighted annual average concentration for atrazine and its chlorinated metabolites in CWSs using surface water of 20 ppb and the highest measured residue in the rural well monitoring data of ~8 ppb. Since the Agency does not expect that levels of the hydroxy metabolites will exceed that of atrazine and the chlorinated metabolites, the concentration of the hydroxy metabolites will not be a significant contributor to risk.

Residential and Recreational Risk

(For a complete discussion, see section 4.4 of the Human Health Risk Assessment)

Workers (Pest Control Operators (PCOs) and Lawn Care Operators (LCOs)) and residents can be exposed to a pesticide through mixing, loading, or applying the pesticide, and re-entering a treated site. Residential risk is measured by a Margin of Exposure (MOE) which determines how close the residential exposure comes to the No Observed Adverse Effect Level (NOAEL) taken from animal studies. Generally, MOEs that are greater than 100 do not exceed the Agency's level of concern. However, since an FQPA safety factor of 3x has been retained for atrazine, MOEs of 300 or greater do not exceed the Agency's level of concern for residents.

- Atrazine is used in the residential setting to control weeds in turf grass. It is also used on golf courses.

- The exposure duration for short-term assessments is 1 to 30 days. Intermediate-term durations are 1 month to six months.

- Homeowner handler and postapplication exposures are estimated for the short-term duration only since exposures greater than 30 days are not anticipated for this use pattern.

- Professional applicators (lawn care operators or LCOs) handler exposures are estimated for the short-term and intermediate-term durations.

- For short-term dermal and inhalation toxicity endpoints, the NOAEL of 6.25 mg/kg/day was used based on on delayed preputial separation (delayed puberty) in male offspring from a 30-day pubertal assay study in rats (LOAEL = 12.5 mg/kg/day). To account for extrapolation from an oral dose to a dermal dose, a dermal absorption factor of 6% was applied with the resulting dermal endpoint for risk assessment being 104 mg/kg/day. This endpoint was selected for the inhalation endpoint due to a lack of inhalation studies.

- For the intermediate-term dermal and inhalation toxicity endpoints, the NOAEL of 1.8 mg/kg/day was used based on attenuation of pre-ovulatory lutenizing hormone (LH) surge as a biomarker indicative of hypothalamic function disruption based on the results of a 6-month LH surge study in rats (LOAEL = 3.65 mg/kg/day). To account for extrapolation from an oral dose to a dermal dose, a dermal absorption factor of 6% was applied with the resulting dermal endpoint for risk assessment being 30 mg/kg/day. This endpoint was selected for the inhalation endpoint from a oral study due to a lack of inhalation studies.

Professional Mixer/Loader/Applicator Residential Risk Estimates

- Mixing/Loading/Application risks to LCOs were estimated for 7 scenarios (lawn handgun using liquid, water dispersable granule, and water soluble bag formulations, backpack sprayer using a liquid formulation, low pressure handwand using a liquid formulation, bellygrinder using a granular formulation and push-type spreader using a granular formulation). A MOE < 100 is considered of concern to the Agency for LCOs.

- Handler exposure assessments were completed using a baseline exposure scenario and, if required, increasing levels of risk mitigation (PPE and engineering controls) in an attempt to achieve an appropriate margin of exposure. The baseline scenario generally represents a handler wearing long pants, a long-sleeved shirt, no respirator, and no gloves. The PPE scenario generally includes baseline attire with the addition of gloves and a dust/mist respirator.

- The Outdoor Residential Exposure Task Force (ORETF) has submitted exposure studies to the Agency including studies concerning application of granular formulations by push-type spreader and LCOs using truck-mounted hoses with handgun sprayers. These data were used, where appropriate, in the assessment of LCO risks.

- Using ORETF data, short-term and intermediate-term MOEs for LCOs are greater than 100 at the baseline level of protection. Therefore, there are no risks of concern for professional lawn control operators from the use of atrazine when utilizing appropriate PPE.

Homeowner Mixer/Loader/Applicator Residential Risk Estimates

- Application risks to homeowners were estimated for 5 scenarios (M/L/A using a backpack sprayer, a low pressure handwand, a push-type spreader with a granular formulation, a bellygrinder with a granular formulation, and a hose-end sprayer). A MOE < 300 is considered of concern to the Agency for residents since an FQPA safety factor of 3x has been applied.

- Handler exposure assessments were completed using a baseline exposure scenario. The baseline scenario represents a handler wearing short pants, a short-sleeved shirt, shoes and socks, no respirator, and no gloves.

- Surrogate chemical-based exposure assessments for each scenario were developed where appropriate using the Pesticide Handler Exposure Database (PHED).

- As mentioned above, the ORETF has submitted exposure studies to the Agency including studies concerning application of granular formulations by push-type spreader and using truck-mounted hoses with handgun sprayers. These data were used, where appropriate, in the assessment of residential risks. Two scenarios (push-type spreaders and hose-end sprayer) were evaluated using both PHED and ORETF data.

- One of the five residential handler scenarios assessed, application via bellygrinder, had an MOE<300 (MOE = 66 when applying to 0.5 acres). There are no risks of concern from the application of atrazine for the remaining residential handler scenarios.

Residential Postapplication Risk Estimates

- Postapplication risks to residents (adults and children) were estimated for 12 scenarios related to potential exposure as a result of treatment of residential turf and golf course turf. Eight (8) of these scenarios evaluate postapplication dermal exposure. The other 4

scenarios evaluate postapplication oral exposure to children (e.g. hand-to-mouth). A MOE <300 is considered of concern to the Agency for residents since an FQPA safety factor of 3x has been applied.

- Postapplication exposures were also considered for 2 aggregated scenarios (oral exposures to children and adult exposures that assume than a person might re-enter a treated lawn, mow a treated lawn and play golf on treated turf on the same day). MOEs were also calculated for adults who apply and re-enter on the same day.

- Chemical specific turf transferable residue (TTR) for both granular and liquid formulations were used together with the revised Residential SOPs to evaluate both dermal and oral exposures.

- Two of the eight dermal exposure scenarios evaluated had MOEs < 300 and are of concern. These scenarios represent dermal re-entry exposures to turf following a liquid formulation application for both children (MOE = 110) and adults (MOE = 190). These exposure scenarios are only of concern when contact is made with wet turf; exposure scenarios based on dry turf are not of concern.

- The aggregate margin of exposure to an adult re-entering a treated lawn, mowing a treated lawn and playing golf on treated turf in an eight-hour period is > 300; thus not of concern.

- Two of the four oral exposure scenarios evaluated for children had MOEs <300 and are of concern. These exposure scenarios are related to hand-to-mouth activity ("finger licking") after application of a liquid formulation (MOE= 210) and ingestion of granules (MOEs from 16 to 110).

- Aggregate oral exposure to children had an MOE<300 and is of concern after the application of liquid atrazine formulations (MOE=190).

Aggregate Risk

(For a complete discussion, see section 5.0 of the Human Health Risk Assessment)

The aggregate risk assessment for atrazine examines the combined risk from exposure through food, drinking water and residential use. Generally, combined risks from these exposures that are less than 100% of the aPAD and cPAD are not considered to be a risk concern. Aggregate risk assessments have been conducted for acute, short-term and intermediate-term to chronic exposures to atrazine and its chlorinated metabolites.

The risk estimates for combined exposures to concentrations of atrazine and the chlorotriazine metabolites in food, drinking water, and through home uses are deterministic and are based on the assumptions and "reciprocal ARI" method as described in HED SOP 99.5. The reciprocal ARI method was necessary because different uncertainty factors have been applied to

dietary (1000x) and residential (300x) risk assessments.

Acute

The acute aggregate risk assessment combines high-end one-day exposures to atrazine and the chlorinated metabolites in food and drinking water for females 13 to 50 years old. The Agency does not anticipate high-end exposures through food, drinking water, and residential use all occurring on the same day. Therefore, acute aggregate risk estimates are the same as those presented for acute drinking water risks. One-day exposure to atrazine from food sources and drinking water does not exceed the Agency's level of concern

Intermediate-Term/Chronic

The intermediate-term and chronic aggregate risk assessment combines exposures to atrazine and the chlorinated metabolites in food and drinking water, only, because intermediate-term (30 days to several months) and chronic (several months to lifetime) exposure scenarios for the registered residential uses of atrazine are not expected. The aggregate risk assessment for intermediate-term and chronic exposures to atrazine and the chlorinated metabolites combines estimates of high-end seasonal or long-term average (chronic) exposures, respectively, to atrazine through drinking water with long-term average exposures through food. Therefore, intermediate-term and chronic aggregate risk estimates are the same as those presented for intermediate-term and chronic drinking water risks. Hence, the adult, infant, and/or children population subgroup(s) are potentially at risk from exposures to combined residues of atrazine plus its chlorinated metabolites in 29 CWS using surface water and for populations using rural wells in areas of high atrazine use.

Short-Term

The short-term aggregate risk assessment combines average exposures to atrazine and the chlorinated metabolites in food and drinking water with residential exposures to atrazine, anticipated to occur between 1 and 30 days after use of atrazine products at home. Short-term aggregate risk estimates inclusive of residential and recreational exposures are only applicable for those regions of the country where atrazine is used on southern turf grasses (generally the Southeast).

Adult Handlers

Short-term estimates of aggregate risk for adults applying atrazine products combines exposures through the dermal, dietary (food and drinking water), and inhalation routes.

Aggregate risks for short-term exposures of adults applying atrazine products to the lawn exceed the Agency's level of concern for adults applying atrazine granular formulations by belly grinder. For the remaining scenarios, aggregate short-term DWLOCs calculated are not exceeded by daily, weekly or seasonal concentrations of atrazine residues in finished drinking water.

Children Postapplication

Short-term estimates of aggregate risk for postapplication exposures of toddlers combine dietary exposures (food and drinking water) with postapplication dermal and incidental oral exposures after lawn treatments.

Aggregate risk estimates for short-term exposures of toddlers playing on atrazine-treated lawns exceed the Agency's level of concern. This assessment is based on the results of the short-term postapplication incidental oral exposure and risk assessment for toddlers plus exposure from food and drinking water. Although dermal, dietary, and incidental oral exposures could be combined for toddlers' postapplication exposures, the Agency notes that toddlers' exposures from individual and aggregated pathways for incidental oral exposures already exceed EPA's levels of concern (MOE=200). Toddlers' exposures from individual and aggregated pathways for incidental oral exposures based on granular formulations do not exceed the Agency's level of concern (MOE=730). Toddlers' short-term dermal exposures also have MOEs less than 300 for liquid formulations under wet conditions. Therefore, any aggregate of exposures with the incidental oral exposures would result in risk estimates that further exceed the Agency's level of concern for toddlers. Because short-term dermal and incidental oral postapplication exposures exist that separately result in MOEs less than 300, the Agency has not aggregated exposures across these routes for toddlers.

Adult Postapplication

Short-term estimates of aggregate risk for adults exposed to atrazine postapplication combine dietary exposures (food and drinking water) and postapplication dermal exposures after lawn or golf course treatments.

Aggregate risks for short-term exposures of adults playing on atrazine-treated lawns immediately after application exceed the Agency's level of concern for the exposure scenario where an adult plays on a lawn treated with a liquid formulation of atrazine. The aggregate short-term DWLOC value calculated for this scenario is exceeded by concentrations of atrazine residues in finished drinking water. All other aggregate scenarios (e.g. golfers) for adult postapplication exposures do not exceed the Agency's level of concern.

Occupational Risk

(For a complete discussion, see section 4.3 of the Human Health Risk Assessment)

People can be exposed to a pesticide while working through mixing, loading, or applying a pesticide, and reentering a treated site. Handler and worker risks are measured by a Margin of Exposure (MOE) which determines how close the occupational exposure comes to a No Observed Adverse Effect Level (NOAEL) taken from animal studies. MOEs greater than 100 do not exceed the Agency's level of concern. For workers entering a treated site, Restricted Entry Intervals (REIs) are calculated to determine the minimum length of time required before workers or others are allowed to re-enter.

- For all short-term exposures, the NOAEL of 6.25 mg/kg/day was used to estimate risk based on delayed preputial separation in males (delayed puberty) as seen in a 30-day pubertal assay (LOAEL = 12.5 mg/kg/day). For dermal exposures, a dermal absorption factor of 6% was applied with the resulting NOAEL of 104 mg/kg/day. An absorption factor of 100% is applied for inhalation exposures.

- For all intermediate-term exposures, the NOAEL of 1.8 mg/kg/day was used based on attenuation of pre-ovulatory lutenizing hormone (LH) surge as a biomarker indicative of hypothalamic function disruption based on the results of a 6-month LH surge study in rats (LOAEL = 3.65 mg/kg/day). To account for extrapolation from an oral dose to a dermal dose, a dermal absorption factor of 6% was applied with the resulting NOAEL of 30 mg/kg/day).

Occupational Handler Summary

- Fifteen major exposure scenarios were identified for atrazine, including mixing, loading, and applying using aerial, ground spray, granular, fertilizer admixture, and lawn application methods. The major handler scenarios involved multiple crops and application rates, resulting in 139 different exposure estimates. The largest agricultural use of atrazine, and the largest potentially exposed occupational population, involves the mixing, loading and application of atrazine to row crops. Most of the occupational exposure studies submitted by the registrant have measured exposure of these workers. There were no exposure data for liquid/liquid fertilizer treatment, so risk estimates for this scenario could not be calculated.

- Dermal and inhalation risks for handlers were combined for each scenario. Handler exposures to atrazine are expected to be both short-term (1 day to one month) and intermediate-term (one to several months).

- Handler exposure assessments were completed using a baseline exposure scenario and, if required, increasing levels of risk mitigation (PPE and engineering controls) in an attempt to achieve an appropriate margin of exposure. The risk estimates presented consider exposures at baseline, i.e., a single-layer of clothing, shoes, socks, and bare hands; exposures with incremental addition of additional protective clothing (PPE) consisting of gloves, coveralls, and respirator; and exposures with engineering controls where closed mixing/loading and application equipment are used.

- On current atrazine labels, personal protective equipment (PPE) requirements for mixer/loaders include long-sleeved shirt, long pants, waterproof gloves, chemical resistant footware plus socks and protective eyeware. For other handlers the requirements include long-sleeved shirt, long pants, waterproof gloves and chemical resistant footware plus socks.

- For short-term exposure estimates based on PHED data, chemical-specific exposure studies, and/or ORETF data with appropriate personal protective equipment (PPE) or engineering controls, all but one (low confidence) handler aggregate exposure scenarios

had MOEs greater than 100, thus, do not exceed the Agency's level of concern. The exposure scenario that does exceed the Agency's level of concern is as follows:

- Mixing/loading/incorporating liquid formulations onto liquid or dry bulk fertilizer (commercial fertilizer; 960 tons treated per day)
  - MOE = 64 at 2 lb ai/400 lb fertilizer

Engineering controls were required to mitigate exposures for seven aggregate exposure scenarios where PPE were insufficient to protect mixer/loaders of liquids or dry flowable formulations for high acreage aerial applications, as follows:

- Mixing/loading liquid formulations for aerial application (1200 acres/day)
  - MOE = 96 for chemical fallow
- Mixing/loading dry flowable for aerial application (1200 acres/day)
  - MOE = 41 for chemical fallow at 3 lb ai/A
  - MOE = 87 for chemical fallow at 1.4 lb ai/A
  - MOE = 61 for CRP/grasslands
  - MOE = 61 for corn/sorghum at 2 lb ai/A
- Open mixing/loading of wettable powders for aerial application (350 acres/day)
  - MOE = 38 for corn/sorghum at 2 lb ai/A
  - MOE = 67 for corn/sorghum at 1 lb ai/A
- Open mixing/loading of wettable powders for groundboom application (200 acres/day)
  - MOE = 67 for corn/sorghum at 2 lb ai/A

- For intermediate-term exposure estimates based on PHED data, chemical-specific exposure studies, or a combination of these data considering appropriate personal protective equipment (PPE) or engineering controls, most aggregate exposure scenarios had MOEs greater than 100; thus, do not exceed the Agency's level of concern. The scenarios that do exceed the Agency's level of concern with engineering controls are as follows:
  - Mixing/loading/incorporating liquid formulations onto liquid or dry bulk fertilizer (commercial fertilizer; 960 tons treated per day; PHED M/L liquid data)
    - MOE = 19 at 2 lb ai/400 lb fertilizer
    - MOE = 38 at 1 lb ai/400 lb fertilizer
  - Mixing/loading/incorporating liquid formulations onto liquid or dry bulk fertilizer (commercial fertilizer; 500 tons treated per day; PHED M/L liquid data)
    - MOE = 36 at 2 lb ai/400 lb fertilizer
    - MOE = 72 at 1 lb ai/400 lb fertilizer
  - Mixing/loading/incorporating liquid formulations onto liquid or dry bulk fertilizer (commercial fertilizer; 500 tons treated per day; Helix study data for engineering control surrogate)
    - MOE = 67 at 2 lb ai/400 lb fertilizer
  - Mixing/loading dry flowable formulations for aerial application
    - MOE = 93 if mixing/loading for 350 acres
  - Mixing/loading dry flowable formulations for groundboom application
    - MOE = 97 for chemical fallow at 3 lb ai/A

Engineering controls were required to mitigate exposures for the following aggregate exposure scenarios where PPE were insufficient:

- Open mixing/loading wettable powders for aerial application (350 acres/day):
  - MOE = 9 for corn/sorghum at 2 lb ai/A
  - MOE = 18 for corn/sorghum at 1 lb ai/A
- Open mixing/loading wettable powders for groundboom application (80 acres/day):
  - MOE = 41 for corn/sorghum at 2 lb ai/A
  - MOE = 82 for corn/sorghum at 1 lb ai/A
- Mixing/loading liquid formulations for aerial application
  - MOE = 61 for conifer forests at 4 lb ai/A (350 acres)
  - MOE = 61 for sugarcane, Christmas tree farms, and turf grown for sod in Florida at 4 lb ai/A (350 acres)
  - MOE = 94 for sugarcane at 2.6 lb ai/A (350 acres)
  - MOE = 82 for chemical fallow at 3 lb ai/A (350 acres)
- Mixing/loading liquid formulations for groundboom application (450 acres/day)
  - MOE = 63 for chemical fallow at 3 lb ai/A
  - MOE = 95 for CRP/grassland at 2 lb ai/A
  - MOE = 95 for corn/sorghum at 2 lb ai/A
- Mixing/loading dry flowable formulations for aerial application
  - MOE = 26 for conifers, forests, sugarcane at 4 lb ai/A (350 acres)
  - MOE = 40 for sugarcane at 2.6 lb ai/A (350 acres)
  - MOE = 35 for chemical fallow at 3 lb ai/A (350 acres)
  - MOE = 74 for chemical fallow at 1.4 lb ai/A (350 acres)
  - MOE = 52 for CRP/grassland at 2 lb ai/A (350 acres)
  - MOE = 52 for corn/sorghum at 2 lb ai/A (350 acres)
  - MOE = 52 for sod farms at 2 lb ai/A (350 acres)
- Mixing/loading dry flowable formulations for groundboom application
  - MOE = 27 for chemical fallow at 3 lb ai/A (450 acres) and
  - MOE = 61 for chemical fallow at 3 lb ai/A (200 acres)
  - MOE = 58 for chemical fallow at 1.4 lb ai/A (450 acres)
  - MOE = 40 for CRP/grassland at 2 lb ai/A (450 acres)
  - MOE = 91 for CRP/grassland at 2 lb ai/A (200 acres)
  - MOE = 40 for corn/sorghum at 2 lb ai/A (450 acres)
  - MOE = 91 for corn/sorghum at 2 lb ai/A (200 acres)
  - MOE = 81 for corn/sorghum at 1 lb ai/A (450 acres)

- Several chemical specific handler studies were used to inform the occupational risk assessment.

- Surrogate-based exposure assessments for each scenario were developed where appropriate using the Pesticide Handler Exposure Database (PHED). Surrogate PHED and Helix exposure study data were used for fertilizer admixture.

- Data are needed to assess the liquid/liquid and to improve the assessment of the liquid/dry fertilizer treatment occupational handler scenarios.

Data quality and confidence in the assessment are important issues that must be considered when interpreting the occupational exposure risk assessment. These include:

- Generic protection factors (PF) were used to calculate handler exposures (e.g., 90 percent PF over baseline for inhalation unit exposure to account for use of an organic vapor removing respirator). These protection factors are considered conservative, but have not been completely evaluated by the Agency.

- Low confidence data, based on PHED grading criteria, were used to calculate the risks to handlers from the following scenarios for any body part and/or level of mitigation: Mixing/loading wettable powders, applying sprays with an airblast sprayer (enclosed cabs), applying sprays with a rights of way sprayer, mixing/loading/applying liquids and wettable powders with a low pressure handwand, mixing/loading/applying liquids with a high pressure handwand and backpack sprayer, and flagging aerial applications. The use of surrogate data for fertilizer admixture scenarios results in low confidence.

Postapplication Occupational Risk

The Agency has determined that there are potential short- and intermediate-term postapplication dermal exposures to individuals entering treated fields. Most of the atrazine used in agriculture is applied to corn and sorghum early in the season, either before weeds emerge or when the crops are quite small (generally less than 12 inches high). This fact, and the degree of mechanization in cultivating these crops, minimizes the postapplication contact of workers with the chemical on these crops. Current labels show a restricted entry interval (REI) requirement of 24 hours with the following early entry PPE required: coveralls, waterproof gloves, shoes, socks and chemical resistant headgear for overhead exposures.

A dose and a MOE are determined from the predicted Dislogeable Foliar Residues (DFR) or Transferable Turf Residues (TTR) values over time until the target MOE of 100 is reached for every crop.

- Atrazine use patterns show short-term (1-30 days) and intermediate-term (1 month to 6 months) dermal exposure is possible for postapplication exposures. Therefore, risk estimates were calculated for both short-term and intermediate-term scenarios.

- For worker re-entry risk, the calculated REI represents the day on which the MOE is greater than or equal to 100.

- Chemical-specific DFR data were available for atrazine, which evaluated dislodgeable residue dissipation for atrazine applied to corn. Chemical-specific TTR data were available for atrazine, which evaluated transferable turf residues for atrazine.

- Transfer coefficients (Tc) used in exposure calculations were based upon data submitted by the Agricultural Reentry Task Force (ARTF), wherever possible.

- Using the average daily foliar/turf residues from each study at day 0-1 and the average 30 day residue after treatment, all but one postapplication short- and intermediate-term dermal risk estimates were below the Agency's level of concern (MOEs range from 68 to 1.4 million). The lowest MOE of 68 was for people scouting sugarcane. Therefore, the current REI of 24 hours does not pose risks of concern to the Agency with the exception of that one scenario.

Ecological Risk

To estimate potential ecological risk, EPA integrates the results of exposure and ecotoxicity studies using the quotient method. Risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values, both acute and chronic, for various wildlife species. RQs are then compared to levels of concern (LOCs). Generally, the higher the RQ, the greater the potential risk. Risk characterization provides further information on the likelihood and impact of adverse effects occurring by considering the fate of the chemical in the environment, communities and species potentially at risk, their spatial and temporal distributions and the nature of the effects observed in studies.

A screening-level ecological risk assessment indicated that risk quotients exceeded the levels of concern for chronic effects on mammals, birds, fish, aquatic invertebrates and non-target plants are possible at maximum and in some cases typical use rates. A refined risk assessment focusing on the aquatic environment and using the extensive exposure monitoring data as well as additional ecotoxicological data found in the open literature, resulted in concerns for adverse toxicological effects on freshwater and estuarine plants and their communities as well as indirect adverse effects on aquatic invertebrate and fish populations at monitored atrazine levels in surface waters.

In addition, the Agency has scientifically reviewed a probabilistic ecological risk assessment submitted by the registrant.

Environmental Fate and Transport

Atrazine is persistent in soil with a half-life exceeding 1-year under some conditions. Atrazine is also mobile since it can be transported to surface water via runoff, spray drift and atmospheric transport and is detected frequently in rainfall. It can also leach into groundwater. These characteristics, together with atrazine's level of use, contribute to widespread water contamination.

- Atrazine is resistant to abiotic hydrolysis (stable at pHs 5, 7, and 9) and to direct aqueous photolysis (stable under sunlight at pH 7), and its moderate susceptibility to degradation in soil (aerobic laboratory half-lives of 3-4 months) indicates that atrazine is unlikely to undergo rapid degradation on foliage. Also, atrazine will probably not undergo rapid volatilization from foliage though some volatilization may occur. In addition, its relatively low adsorption characteristics indicate

that atrazine may undergo substantial washoff from foliage.

- In field studies, atrazine dissipated with half lives of 13, 58, and 261 days, respectively. The inconsistency in these reported half-lives could be attributed to the temperature variation between the studies in which atrazine was seen to be more persistent in colder climate. Long term field dissipation studies also indicated that atrazine could persist over a year in such climatic conditions.

- For aquatic environments reported half-lives were much longer. In an anaerobic aquatic study, atrazine overall, water, and sediment half-lives were given as 608, 578, and 330 days, respectively.

- The soil/water partitioning of atrazine and its chloro-metabolites is relatively low. The hydroxy-metabolites have higher soil/water partitioning than both atrazine and the chloro-metabolites which means they tend to bind more readily to soil resulting in less runoff potential.

- Atrazine should be somewhat persistent in ground water and in surface waters with relatively long hydrologic residence times (such as in some reservoirs). The reasons for this are the resistence of atrazine to abiotic hydrolysis and to direct aqueous photolysis, its moderate susceptibility to biodegradation, and its limited volatilization potential.

- The relatively widespread detection of atrazine and various chlorinated metabolites in monitoring data for surface water and rural wells is consistent with the widespread use of atrazine, the persistence of atrazine and the mobility of atrazine and its chlorinated metabolites. The lower frequency of detection and generally lower levels of the hydroxy-metabolites in rural wells is consistent with its higher soil/water partitioning than atrazine and the chlorinated metabolites.

Nontarget Terrestrial Organism Risk

- Avian and mammalian RQs do not exceed levels of concern for acute risk.

- Avian RQs exceed levels of concern for chronic risk at current maximum and typical application rates. Chronic RQs for maximum application rates range from 0.13 - 4.3 (sugarcane). Chronic RQs for typical application rates range from 0.08 - 2.8.

- Mammalian RQs exceed levels of concern for chronic risk at current maximum and typical application rates. Chronic RQs for maximum application rates range from 3.0 - 96 (sugarcane). Chronic RQs for typical application rates range from 1.6 - 62.

Nontarget Aquatic Organism Risk

- Freshwater invertebrate and fish RQs do not exceed levels of concern for acute risk.

- Freshwater invertebrate and fish RQs slightly exceed levels of concern for chronic risk

for the sugarcane scenario only. Chronic RQs range from 1.9 - 3.1 for sugarcane using maximum and typical rates.

- The assessment indicates that both vascular plants and algae will be impacted by atrazine use.

Nontarget Plant Risk

- For aerial applications, three out of the ten non-target crops (i.e., cucumbers, soybeans and cabbage) evaluated are at risk from exposure as a result of spray drift alone, if grown adjacent to atrazine-treated sugarcane treated with the maximum registered use rate. Of the ten crops, only corn is not at risk from combined spray drift and runoff exposures.

- For ground applications, three out of the ten non-target crops (i.e., cucumbers, soybeans and cabbage) evaluated are at risk from exposure as a result of spray drift alone, if grown adjacent to atrazine-treated sugarcane ground treated with the maximum registered use rate. The combination of spray drift and runoff poses risks to eight out of the ten crops if grown in dry habitats and to nine out of ten crops if grown in low-lying, semi-aquatic habitats.

Community-Level Risk Concerns

- Aquatic ecosystems are at risk from atrazine use, especially those in high use areas. This is based upon atrazine's toxicity to aquatic plants, associated indirect effects on invertebrate and fish populations (destruction of habitat important for predator avoidance and sensitive organisms lower on the food chain), and community level effects such as species composition and photosynthetic efficiency. Effects are likely to be greatest where concentrations of atrazine in water recurrently or consistently exceed 10 to 20 ppb.

- Modeled concentration values were generated for 36 years and compared to key endpoints. Community effects in ponds were predicted in 100% of years from use on sugarcane and sorghum and 70-83% of years from use on corn. The modeled values for ponds are somewhat higher than most of the monitored values for the aquatic ecosystems evaluated, with the exception of monitoring in Louisiana waters receiving runoff from sugarcane and corn production. Monitoring levels in those waters matched peak modeled values very closely.

- Monitored surface water values from community water systems have been seen at levels that exceed the endpoints for community impacts in some cases. Stream concentrations from various monitoring data sometimes exceeded key endpoints. This was especially true where pulses were observed.

- Reported sub-lethal effects of atrazine include endocrine effects in bass and frogs, and olfactory effects in salmon. Other studies have shown no effects in frogs, Daphnia, turtle eggs and alligator eggs. Additional research is ongoing to investigate these effects, and will be considered as appropriate in risk management decisions.